F-35 Lightning II

Technology Transition

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Dr. Jim M. Alper
Science & Technology Lead, F-35 Lightning II Program

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VISION

DELIVER AND SUSTAIN
THE MOST ADVANCED, AFFORDABLE STRIKE FIGHTER AIRCRAFT TO PROTECT FUTURE GENERATIONS WORLDWIDE.

MISSION STATEMENT

BE THE MODEL ACQUISITION PROGRAM FOR JOINT SERVICE AND INTERNATIONAL COOPERATION.
DELIVER TO OUR WAR FIGHTERS AN AFFORDABLE AND EFFECTIVE NEXT GENERATION STRIKE FIGHTER WEAPON SYSTEM AND SUSTAIN IT WORLDWIDE.

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Positioned for Long-Term Growth

LOCKHEED MARTIN

30+ Years of Production

Over 4,300 Delivered

Global Program

F-16 Like Potential

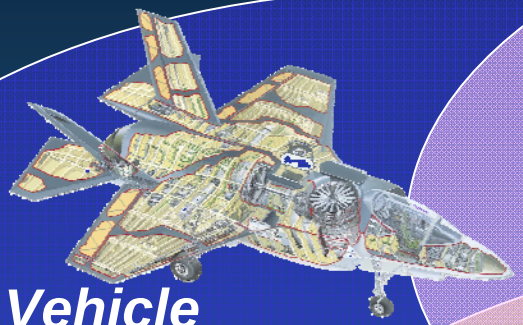
Originally < 1,000 Projected

Multiservice, Multinational Program

US Fighter Force Structure Recapitalization
Mirrored in Coalition Partner Fleets

F-35 Is the Future

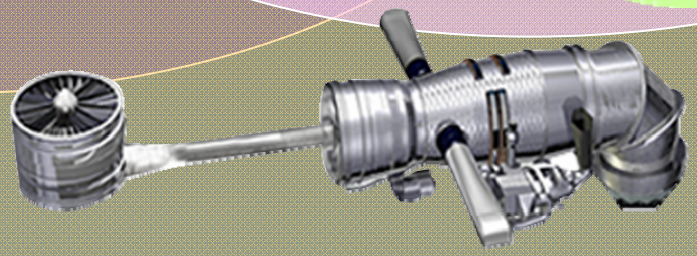
F-35 Is a Complex Air System



Air Vehicle
- 3 Major Teammates
- Global Supply Chain

Autonomic Logistics & Global Sustainment
- Reduced Ownership Cost
- Performance Based Logistics

Air System



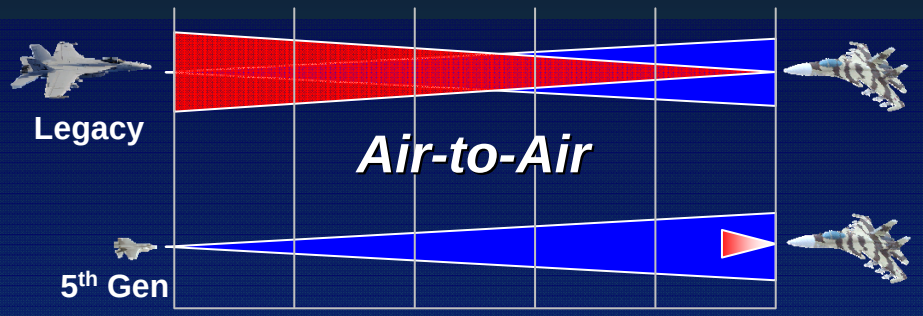
Propulsion
- 3 Major Companies
- Global Supply Chain

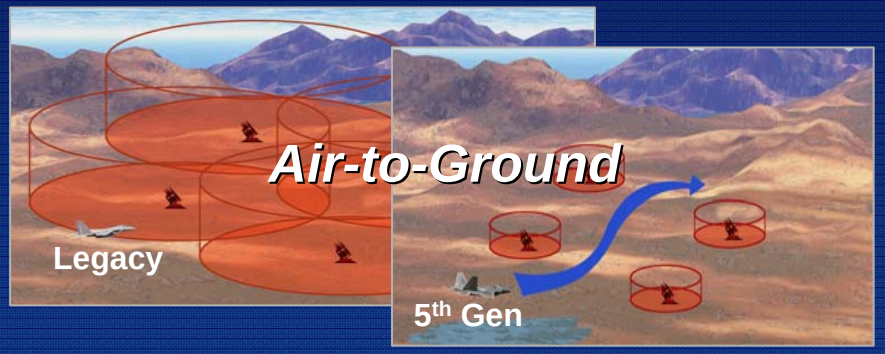
The Element of Surprise……

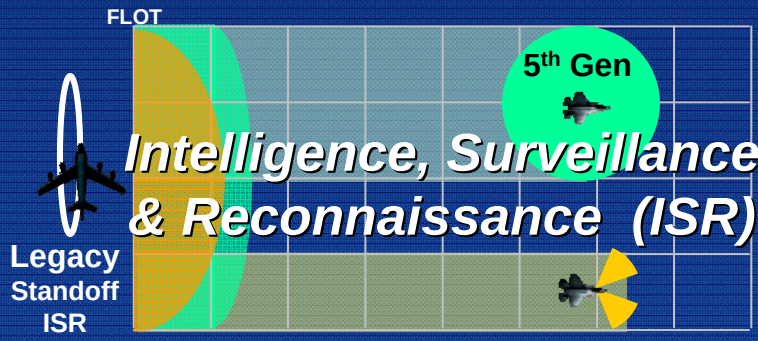
5th Generation Fighters Uniquely Integrate:

F-35

- Stealth
- Fighter Performance
- Total Situational Awareness
- Advanced Sustainment







Unmatched Counter Air, Strike, and ISR Mission Capability Increases The Effectiveness of Legacy Forces

Complex Packaging

Federated Subsystems

Emergency & Auxiliary Power Units

Hydraulic Actuators Powered by Central Hydraulics

Air Cycle Environmental Control System

Vapor Cycle Environmental Control System

Airframe Mounted Accessory Drive

Integrated Subsystems

Electro Hydrostatic Actuators

Switched Reluctance Starter /Generators on Engine

Fan Duct Heat Exchanger

Integrated Power Package (IPP)

Highly Integrated Vehicle Systems Drives More Electric Architecture

….Plus Near Perfect Situational Awareness

Electro-Optical Targeting System (EOTS)

Full Spherical Coverage by Distributed Aperture System (DAS)

RWR
360° Coverage

Active Electronically Scanned Array (AESA)

RADAR

DAS Apertures

Electronic Support Measures

Emitter Locating

- SATCOM
- Data Links

All Aspect Stealth – Low Observable

Enabled By a Decision Making Cockpit…..

Exceptional Situational Awareness

Digital Thread Throughout Life-Cycle

LOCKHEED MARTIN

Development

Design

Build

Program Management

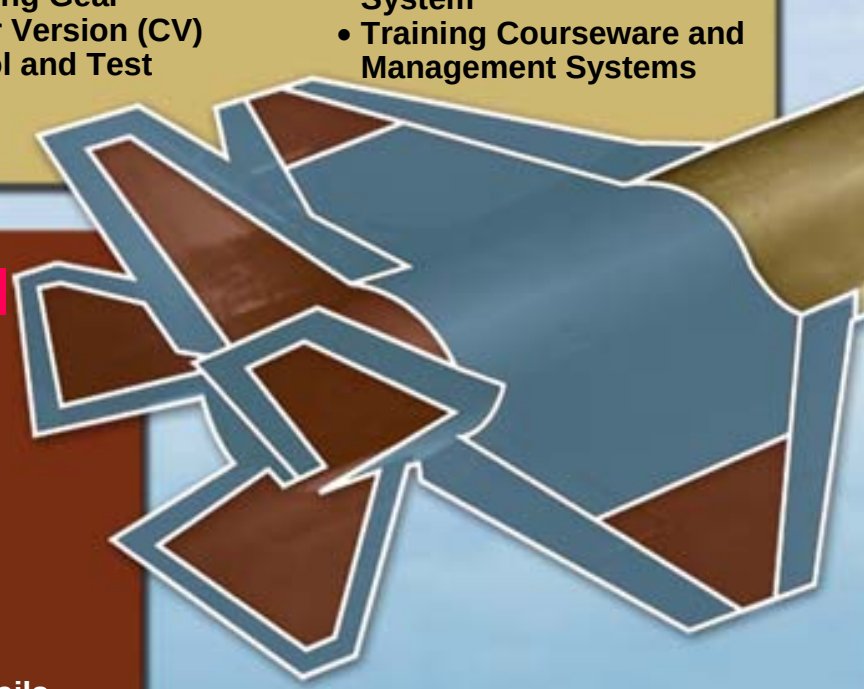
Support, Maintain and Train

Test

JSF Team

NORTHROP GRUMMAN

- Center Fuselage
- Weapons Bay Door Drives
- Arresting Gear
- Carrier Version (CV) Control and Test
- Radar
- Software
- Low Observable Support System
- Training Courseware and Management Systems



BAE SYSTEMS

- Aft Fuselage
- CV Wing Fold
- Fuel System
- Crew Escape
- Life Support
- EW System
- U.K. Support Center
- Throttle/Side Stick
- Horizontal/Vertical Tails
- Flight Control Computer
- STOVL Control and Test
- U.K. Rqts/Stores/SW

LOCKHEED MARTIN

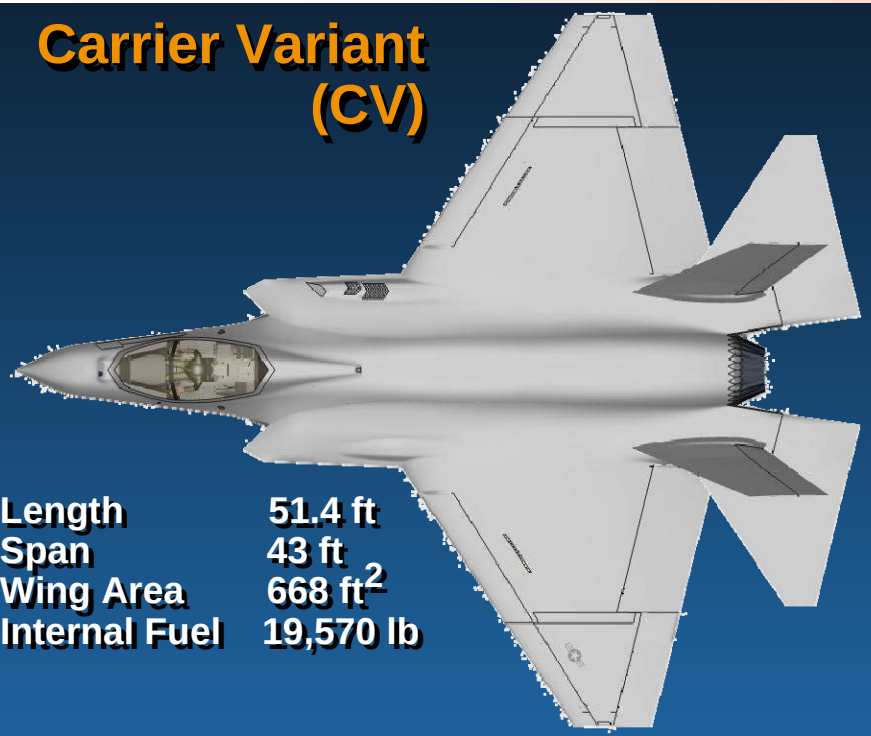
Prime Contractor

- Air System Verification
- System Integration
- Mate Through Delivery
- Edges & Control Systems
- Autonomic Logistics
- Mission Systems
- Vehicle Systems
- Training System
- Forward Fuselage
- Wing

A Highly Integrated Global Team

Multi-Service Design

Carrier Variant (CV)



Length	51.4 ft
Span	43 ft
Wing Area	668 ft^2
Internal Fuel	19,570 lb

Conventional Take-Off and Landing (CTOL)

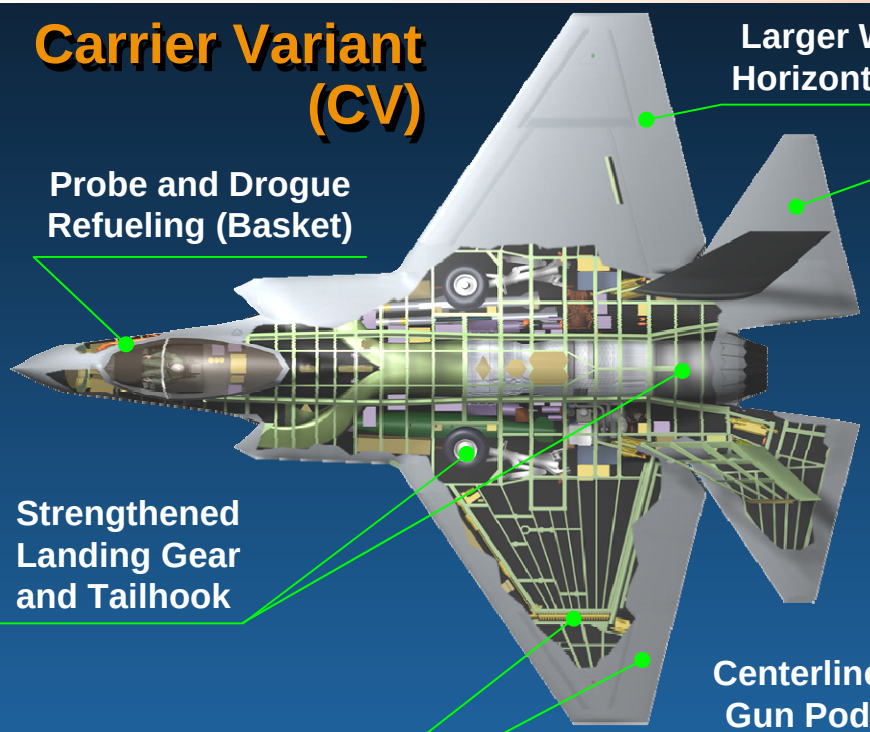
Length	51.1 ft
Span	35 ft
Wing Area	460 ft^2
Internal Fuel	18,073 lb

Length	51.1 ft
Span	35 ft
Wing Area	460 ft^2
Internal Fuel	13,888 lb

Short Take-Off and Vertical Landing (STOVL)

Lockheed Martin Multi-Service Design

Carrier Variant (CV)



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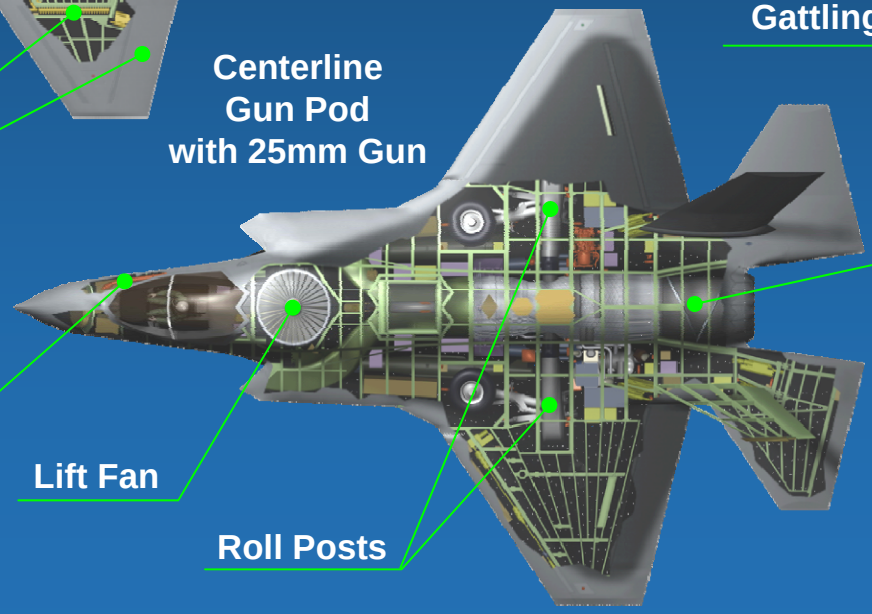


Short Take-Off and Vertical Landing (STOVL)

International Parts Flying on 1st CTOL Aircraft

Life Support System
Honeywell Aerospace Yeovil - UK

Center Fuselage Metal Parts
Kalekalip -Turkey

Opening Doors
Fokker - Netherlands

Ejection Seat
Martin Baker - UK

Aft Fuselage & Structural Components
BAE SYSTEMS - UK

Emergency UHF Radio
Selex - Italy

Weapons Bay Door Drive/Utilities
Goodrich - UK

Composite Materials
Cytec Fiberite - UK

Noseboom Assembly
TERMA - Denmark

Cockpit Panels and Lighting
Selex - Italy

3-Bearing Swivel Nozzle
Rolls Royce - UK

Throttle Quadrant
BAE - UK

CTOL Arresting Gear
STORK SP - Netherlands

F135 Low Pressure Turbine Shaft
Volvo Aero Norge - Norway

Pilot Flight Equipment
Beaufort - UK

Wiring Harnesses
Fokker ELMO -Netherlands

Engine Removal and Installation Trailer
Marand - Australia

Wheels and Brakes
Dunlop - UK

Fuselage Remote Interface Units
Electrical Power System
GE Aviation - UK

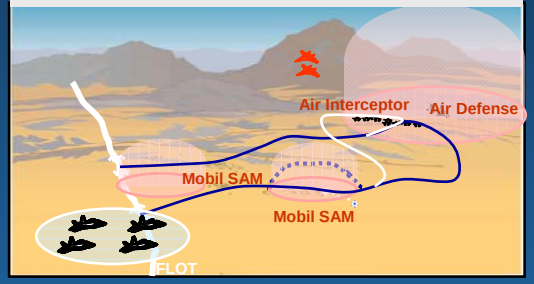
Power Thermal Management System
Honeywell - Canada

All 8 International Partners Have Parts on 1st Flight Test Aircraft

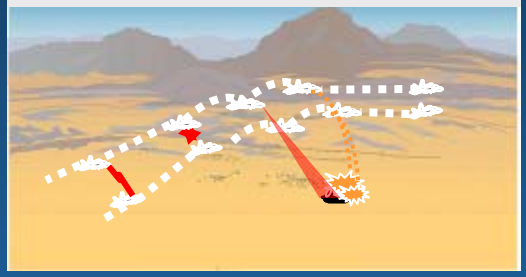
What F-35 Provides to the Warfighter

- **Day "One" Stealthy (VLO) Supersonic, Multi-Role Fighter designed to execute Air-to-Air and Air-to-Ground missions in high threat areas:**

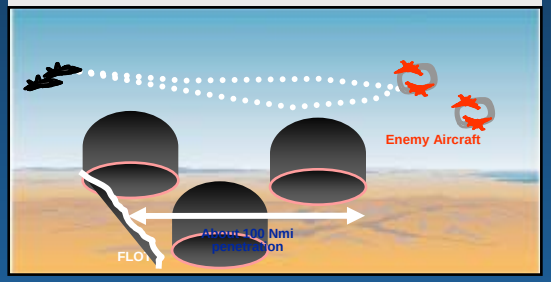
Air Interdiction
Fixed, Stationary& Moving Tgts



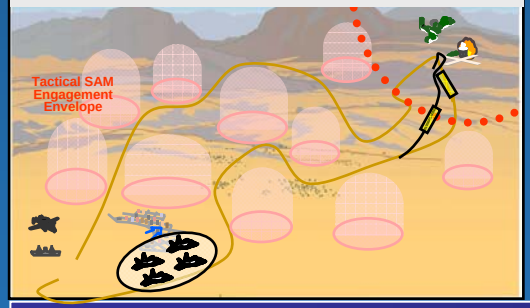
SEAD & DEAD
(Strategic & Tactical)



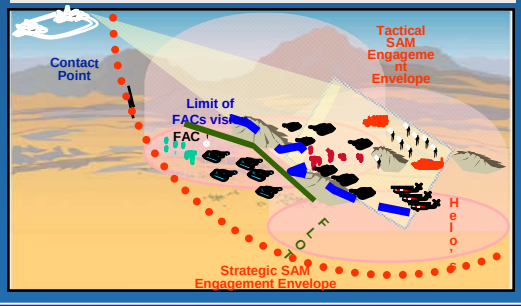
Offensive Counter Air
(Fighter Sweep/Escort)



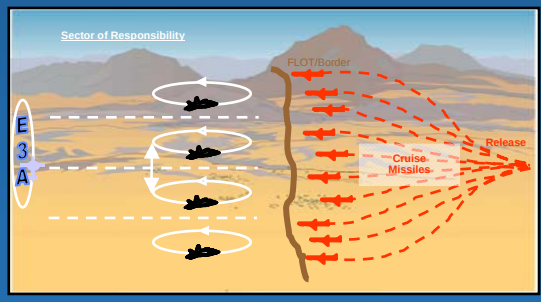
Strategic Attack
(Bunkers and Shelters)



Close Air Support
(Precision Day/Night Adv WX)



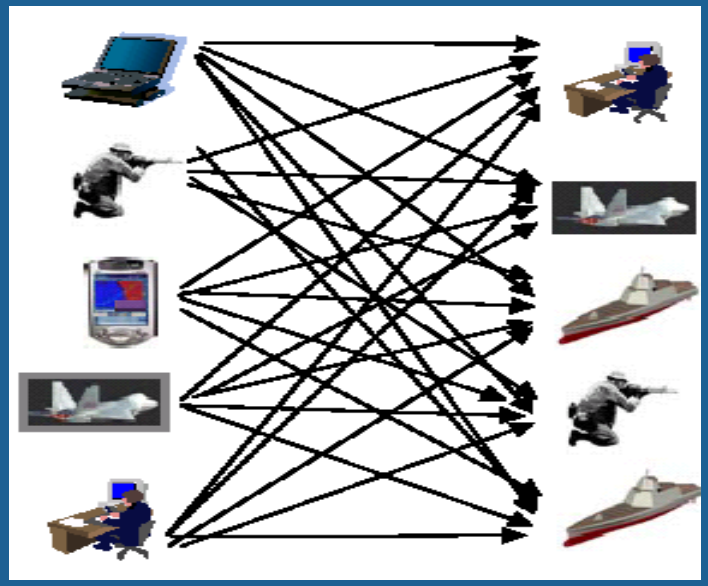
Defensive Counter-Air
(Fighters, Bombers & Cruise Missiles)



Versatile fighter which fulfills multiple missions

JSF In Middle of Warfighting Transformation

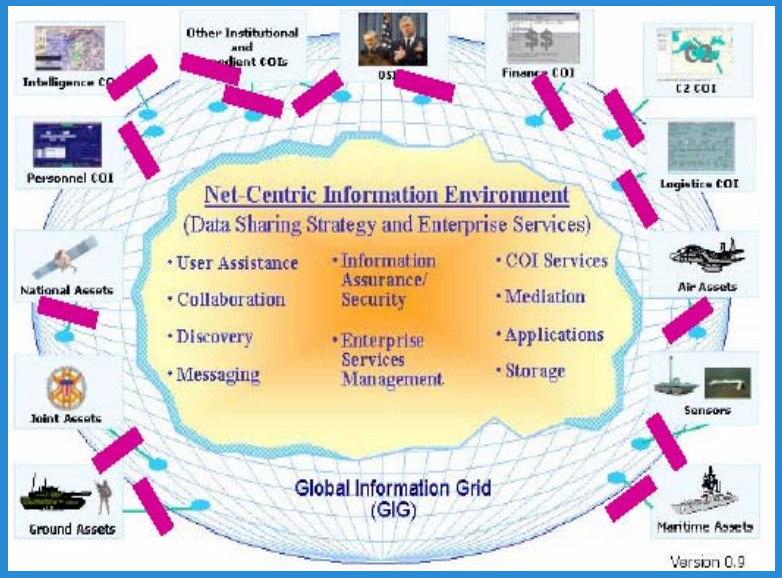
Present Environment



One-to-One Exchanges

- Interoperability Defined by Information Exchange Requirements (IERs)
- Strategy – Satisfy via Standards To Be Compatible With 2010 Architecture Defined via This Approach
- Measured by a Interoperability KPP

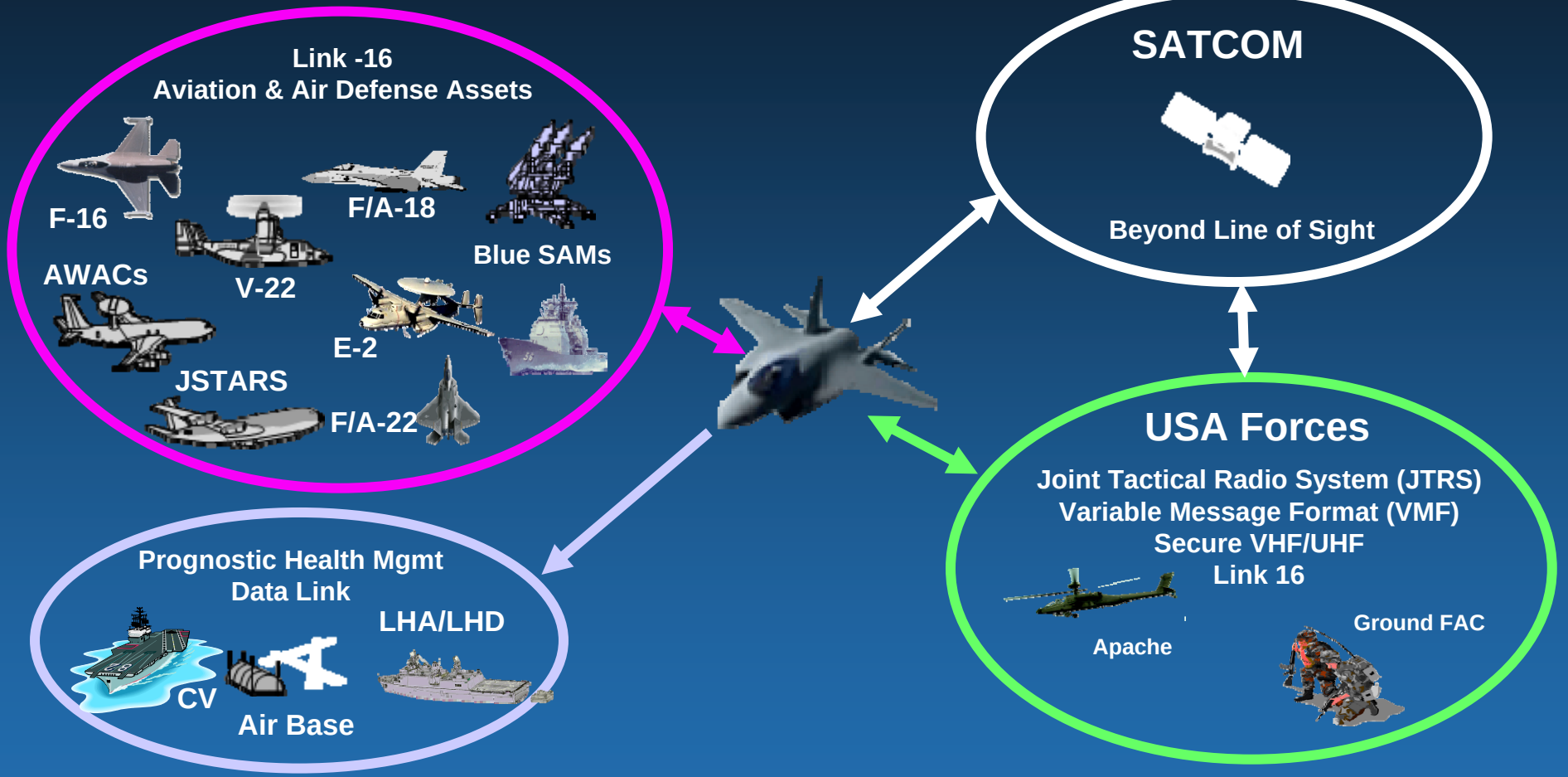
Net-Centric Environment



One-to-Many Exchanges

- "Publish and Subscribe" Networks
- Strategy – Develop JSF Air System With Sufficient Flexibility To Adapt To Changing Environment
- Managed Networks – Key Interface Profiles (KIP) and Enterprise Services
- Measured by a Net-Ready KPP

Voice and Data Link Interoperability

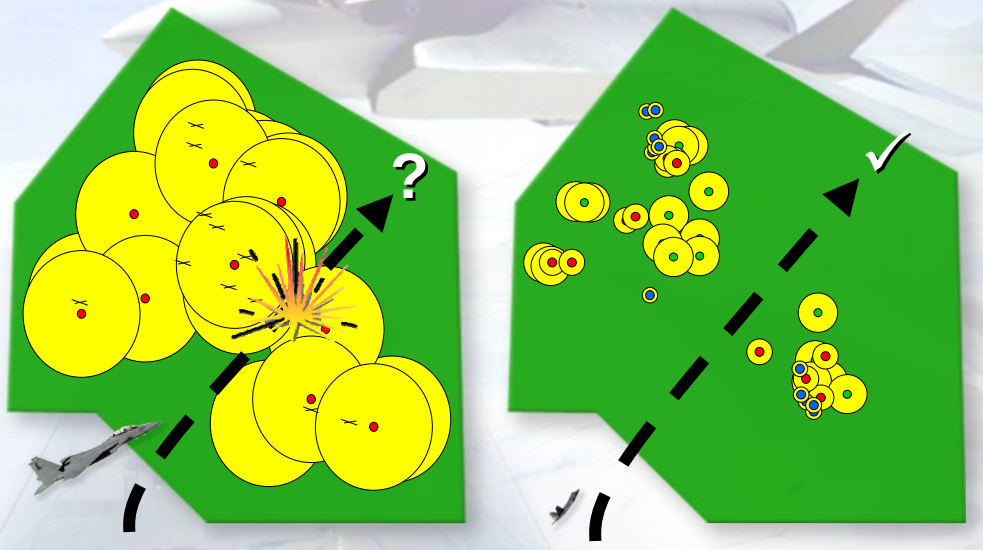


Over 120 Information Exchange Requirements to Ensure Interoperability Across US and Coalition Forces

Survivability and Lethality

F-35: Designed and Built for Agile Stealth

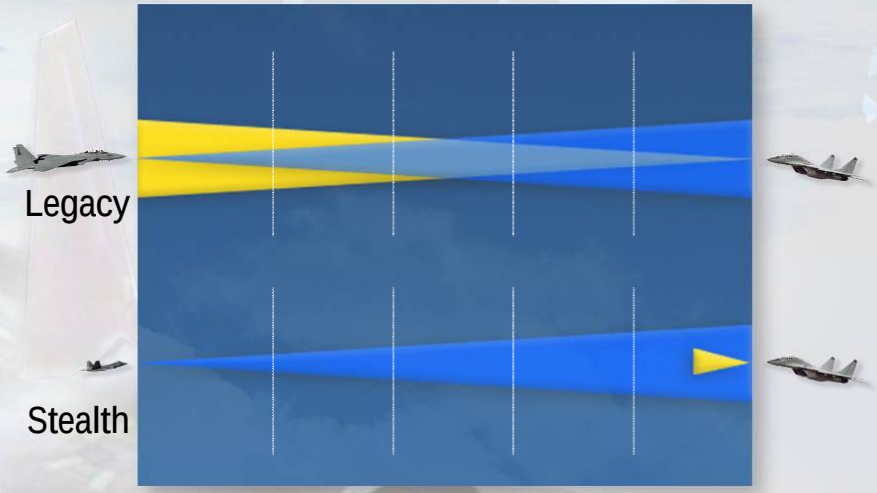
Survivable Theater Access . . .



Legacy TACAIR
- Engaged and Shot by Ground Defenses
- Surprise Lost
- Mission Effectiveness Degraded/Lost
- Access Denied

5th Gen TACAIR
- No Tracks, No Shots
- Surprise Maintained
- Survivable and Lethal
- Access Assured

. . . With Increased Lethality



Stealth Shrinks Air-to-Air Detection Capability

Tremendous Improvements in Combat Capability, Operational Flexibility, and Overall Force Efficiency in All Mission Areas

Master Schedule

FY	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
CY	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015

Major Program Events

Critical Design Reviews
- USAF / USMC
- USN CDR

First Flights
- USAF
- USMC
- USN

Initial Operational Capability
- USMC
- USAF
- USN

Test Completions
- Developmental
- Operational

Low-Rate Initial Production (LRIP)

Production and Sustainment
- LRIP 1 (2)
- LRIP 2 (12)
- LRIP 3 (19)
- LRIP 4 (32)
- LRIP 5 (47)
- LRIP 6 (118)
- LRIP 7 (132)
- Multi-Year 1 — EOQ — MYP →

Planned U.S. Production and Sustainment
- Air Force 1,763 A/C
- Dept of Navy 680 A/C

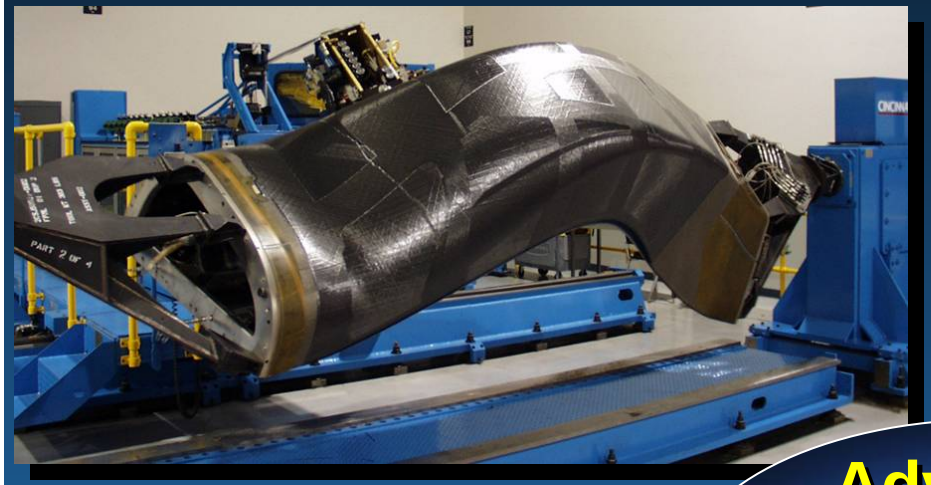
Planned International Production > 500

EOQ = Economic Order Quantity MYP = Multi-Year Procurement

Accomplishments Since Summer 2007

- **AA-1 Achieved 24 Successful Flights**
  - ***Performed in-flight refueling with excellent flying qualities***
- **CATB Operations Initiated – CNI Successful Testing**
- **Joint Agreement of Functional Baseline Spec (FBS) & Verification Process**
- **Final Block 3 International Evaluations Successful**
- **CV CDR Completed**
  - ***CV EPS/EHAS Solution Established***
- **96% of Initial BTPs and 56% (9.5M) of SLOC Released**
- **All 3 Variants in Production**
  - ***CTOL and All STOVLs in Mate***
- **BF-1 Readied for Flight**
  - ***Mitigated STOVL Propulsion System Delays***
- **DAB Approved:**
  - ***Full Funding for LRIP 2 (6 CTOL and 6 STOVL)***
    - Pending BF-1 FF + F135 turbine blade redesign resolution
  - ***Long Lead for LRIP 3 (8 CTOL / 8 STOVL)***
  - ***1 year extension of SDD to complete DT and OT***
- **Stabilized URF Estimates**

Precision Fabrication



Flexible/Automated Solutions

Advanced Manufacturing Technologies

Lean Practices

Digital Assembly

2008 Milestones

Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec

- LRIP #2 CTOL FF Approved
- BF-1 Structural Coupling Tests Start

- BF-1: Hover Pit Testing

- CF-1 FRR

- BF-1 1st Flight

- BG-1 Begin Structural Tests

- AA-1 Launch to EAFB

- LRIP #2 STOVL FF Approved
- BF-2 Rollout

- LRIP #3 LL Approved
- LRIP #3 FF Proposal Submitted
- AF-1 Power On

- BF-3 Rollout

- CF-1 Start Major Mate

- Sustainment Readiness Review-PAX

- AF-1 Rollout

- BF-4 Rollout

- CATB 1st Federated Flt

- Maintenance Training CDR

- ALIS 1.0.2 Delivery

- AG-1 Static Test Start

Flight Test Underway

Objectives

- Mission Systems Risk Reduction
- Missions Systems Integration
- Verification

Status

- 37 Flights; 105.7 Flt Hrs, 13.5 Test Hrs
- CNI Sorties – Good flight test data obtained
- Radar and EW integration mod underway
- Block 0.5 Mission Systems testing starts Oct 08

Objectives

- Risk Reduction
- Basic Envelope Expansion
- Systems Integration

Status

- 43 Flights, 51.7 Flt Hrs
- 38,000 Feet, 0.89 Mach, 20 Degrees AoA
- Initial Air Refueling Tests Complete
- Air Starts planned during EDW deployment

CATB 23 Jan '07

11 Jun '08 STOVL

2009 CTOL

2009 CV

As of 28 Mar 08

BF-1 Status

Roadmap

• Airworthiness	Jun-Jul 08
• Flying Qualities	Aug-Sep 08
• Hover Pit	Feb 09
• Initial STOVL Transition	Mar 09
• Ferry to PAX River	Apr 09
• Vertical Landing Buildup	May-Jul 09

Flight Test Status

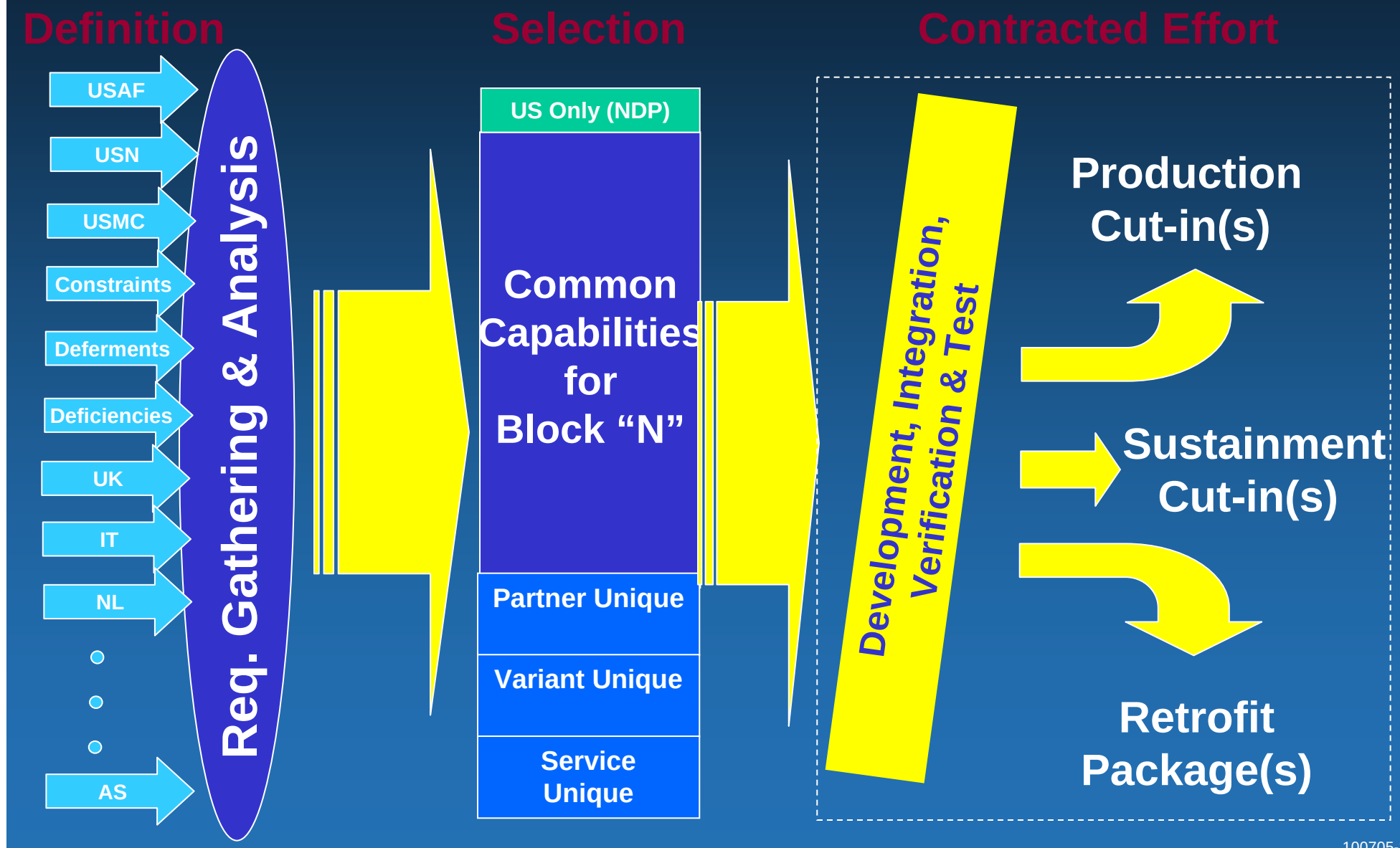
- 1st Flight – 11 Jun 08
- 4 Flights, 3.3 flight hours
- Altitude to 15K / 275 KCAS max
- Multiple land gear cycles at 200 KCAS

The Future Is Upon Us

	BLK 0.5		BLK 1	BLK 2	BLK 3 →													
	LRIP 1	LRIP 2	LRIP 3	LRIP 4	LRIP 5	LRIP 6	LRIP 7	MY 1					MY 2					
Buy Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
Delivery Year	2010	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	
USAF - CTOL	2	6	8	12	24	42	48	66	80	80	80	80	80	80	80	80	80	
DoN - CV				4	6	15	17	25	25	25	25	25	25	25	25	25	25	
DoN - STOVL		6	8	14	13	25	25	25	25	25	25	25	25	25	25	25	25	
UK - STOVL			2	1		6	1	8	11	12	13	12	12	7	2	1	1	
IT - STOVL						4	3	3	3	3	14	14	12	1				
IT - CTOL						2	3	11	11	11				11	12	12	1	
AS - CTOL					4	8	15	15	15	15	15	13						
CA - CTOL								16	16	16	16	16						
DK - CTOL								8	8	8	8	8	8					
NL - CTOL			1	1		6	10	10	12	12	12	12	9					
NO - CTOL								8	12	12	12	4						
TR - CTOL						10	10	10	12	12	10	10	10	10	6			
TOTAL	2	12	19	32	47	118	132	205	230	231	230	219	181	159	150	143	132	

Source: JSF.mil website – Annex A Revision April 2007

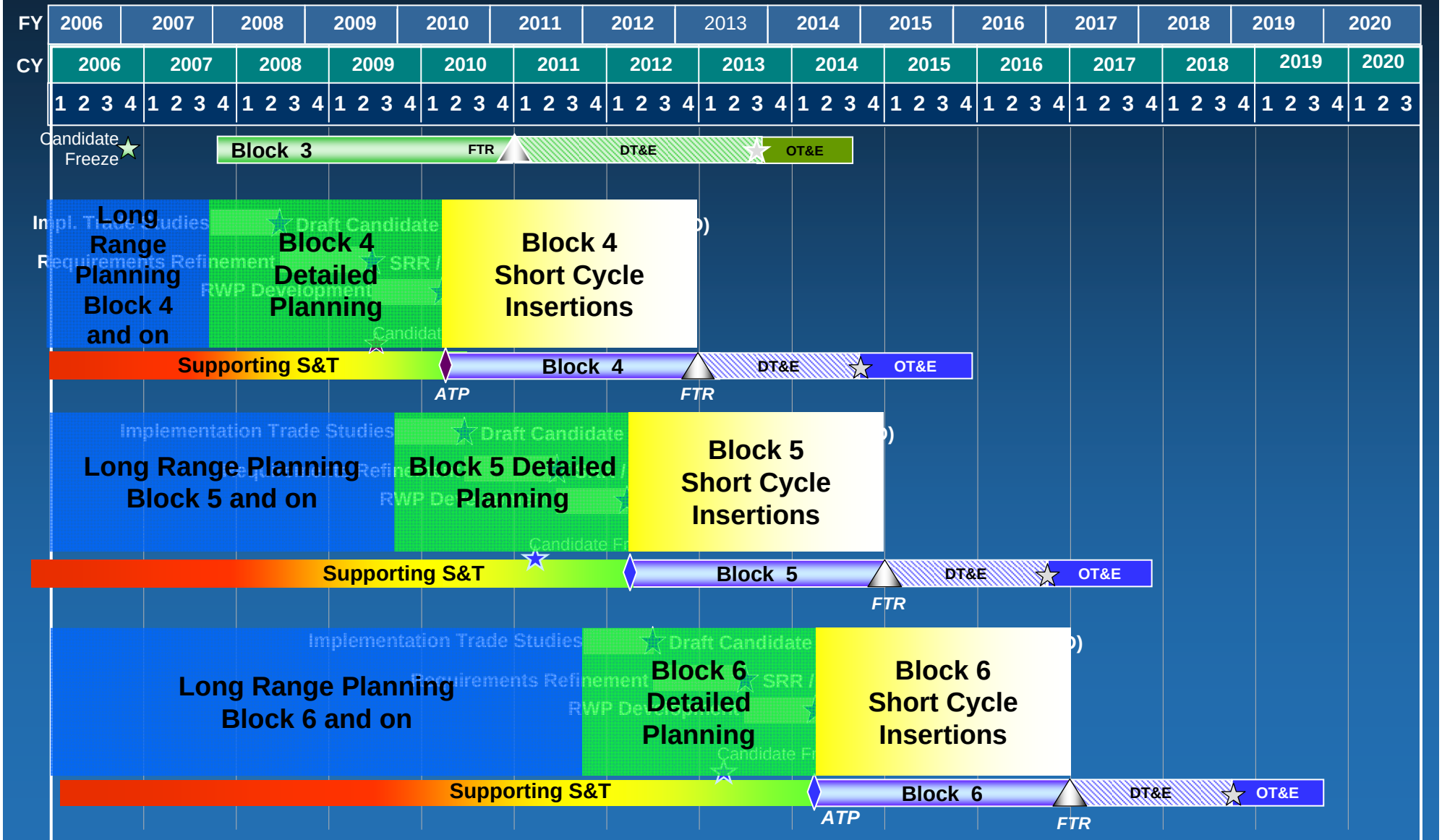
Follow-on Development Concept



Post-SDD Block Increment Planning

Notional Timelines

"Technology Insertion Points"



Follow-on Development - Platform Contractor/JPO are doing our Homework

- **Contractor/JPO are developing Roadmaps to show**
  - *What* ***the warfighter's needs are – COCOM Gap Analysis***
  - *Where* ***are we going in "focus areas"***
  - *When* ***technologies need to fit into the JSF S&T roadmap***
- **S&T programs must buy their way into the JSF Air System**
  - *Measurable* ***IMPROVED performance, reliability & maintainability and/or supportability basis***
  - *A solid business case*, ***i.e. REDUCED URF (Unit Recurring Flyaway Cost), Total Ownership Cost, and ROI (Return on Investment)?***
- **JSF S&T Planning Document**
  - ***Provides technology needs, priorities and schedule***
  - ***Available on request as appropriate***

JSF S&T Future Planning

- **JSF S&T Focus**
  - *Incorporate mature technologies into baseline*
  - *Increasing capabilities for strike warfare*

- **JSF S&T Planning Document**
  - *Strategy & guidance for investments*
  - *Potential Enhancements*
  - *Roadmaps & projects*

S&T Technology Opportunity Categories

- Air System Core Capability
- Air-to-Surface
- Air-to-Air
- Electronic Combat
- Interoperability and ISR
- Airframe & Infrastructure
- Supportability / Sustainment
- Manufacturing and Producibility

Technology Roadmap Needs

- **Air System Core Capability**
  - *Collision Avoidance*
  - *Cockpit Automation*
  - *Embedded Training*
- **Air-to-Surface**
  - *"Dial a Yield" Weapons*
  - *Combat ID*
  - *Locate Targets in Complex Environments*
  - *Small Weapon Precision Kill*
  - *Improved Battle Damage Assessment*

Technology Roadmap Needs

- **Air-to-Air**
  - *Combat ID*
  - *Longer Range Missiles*
  - *Faster Missiles*
  - *Passive Threat Detection*
- **Electronic Combat**
  - *Threat Detection*
  - *Active Countermeasures*
  - *Electronic Attack*
  - *Directed Energy Effects*

Technology Roadmap Needs

- **Interoperability and ISR**
  - *LPI Networks*
  - *Information and Resource Management*
  - *Improved Bandwidth*
  - *Battle Management*

- **Airframe and Infrastructure**
  - *Propulsion (Fuel/Thrust)*
  - *Reduced Weight*
  - *Thermal Management*
  - *Mass Storage Capacity*
  - *Electric Power and Power Electronics*
  - *Actuator Systems*

Technology Roadmap Needs

- **Supportability and Sustainment**
  - *Fault Detection and Isolation*
  - *Non-skid Coatings*
  - *Diagnostics, Prognostics, and Health Monitoring*
  - *Environmentally Safe Primers and Coatings*

- **Manufacturing and Producibility**
  - *Span Time Reduction*
  - *High Temperature Materials*
  - *Assembly Automation*
  - *Supportable and Affordable LO Technologies*
  - *Coatings*

S&T Opportunities

- **Requirements Pull**
  - ***Potential Themes for Upgrades***
    - Missions
    - Emerging Threats
    - Basic Capabilities
    - Net Centric Capabilities
    - Sustainment
    - Enduring Themes (Weight, URF, Production, Thermal)
- **Technology Push**
  - ***What aren't we thinking about?***
    - Emerging Technology
    - ???

Effective Transition Planning

- **Technology must satisfy a valid requirement**
- **Candidate must have a high Benefit to Cost ratio**
- **Project(s) must have a feasible Business Plan**
- **Development Funding Sponsorship must be identified**
- **Technology Transition Agreement / Plan must be written**
  - ***Clearly defined success criteria***
  - ***Alternatives & Offramps identified***
  - ***Transition funding identified (as required)***
- **Essential to maintain close coordination**
  - ***Technologists; IPTs; Management;***
    Requirements community
    Acquisition Funding community
  - ***Formal and informal communication***

Leveraging External Funding

- **JSF Program funds very limited for transition**
- **Need to establish the tech transition path to the platform early on through prime contractor and sub-prime involvement**
  - ***JSF is a Total System Performance Responsibility (TSPR) program. No technology makes it on the jet without the Prime and Sub-prime's concurrence!***
- **Focus is to leverage non-JSF funding for transition such as:**
  - ***Service programs***
    - Warfighter Rapid Acquisition Program (USAF WRAP)
    - Rapid Technology Transition (USN RTT)
    - Manufacturing Technology (USAF & USN MANTECH)
    - SBIR Commercialization Pilot Program (CPP)
  - ***DoD Programs***
    - Technology Transition Initiative (TTI)
    - Defense Acquisition Challenge Program (DACP)
    - Foreign Comparative Testing (FCT)

JSF US Funding Opportunities for Technology Transition

Near Term

Relatively High Technology Readiness Levels TRL 6 to 9

- Tech Transition Initiative (OSD)
- Rapid Technology Transition (USN)
- Tech Solutions (USN)
- DoD Corrosion (OSD)
- Commercial Technologies for Maintenance Activities (OSD)
- Weapons Rapid Action Program (USAF)
- Technology Insertion Program (USN)
- Defense Acquisition Challenge Program (OSD)
- Sea Trial (USN)
- Quick Reaction Fund (OSD)
- Naval Innovation Lab (USN)
- JSF S&T Advisory Board

Mid Term

- Swamp Works (USN)
- Future Naval Capabilities (USN)
- Foreign Comparative Testing (OSD)
- Advanced Concepts Technology Demonstrations (OSD)
- Operational Logistics Integration program (USN)
- NAVAIR Tech Commercialization Initiative (USN)
- Manufacturing Technology (USN, USAF)
- Navy International Cooperative Program (USN)
- Coalition Warfare Project (OSD)
- SBIR
- STTR

Far Term

Relatively Low Technology Readiness Levels TRL 1 to 3

- Discovery & Invention (USN, USAF)
- Small Business Innovation Research (USN, USAF) (SBIR)
- Industry Research and Development
- Defense Exchange Agreements (OSD)
- Small Business Technology Transfer (STTR) Program (USN,USAF)
- DARPA Projects (OSD)

Present . . . . . 5 Years . . . . . 20 Years . . . . . .

New Technology Requirements Summation

- **Communicate the technology challenge**
  - ***Product***
  - ***Timeline***
- **Identify potential solutions**
  - ***Is the technology challenge already being addressed***
  - ***Are there technology gaps that need to be addressed***
  - ***Where can we leverage funding***
- **Planning doesn't end today. It's an ongoing process.**

JSF S&T Team

- JPO Arlington
  - ***Dr. Jim Alper (703) 601-5516, james.alper@jsf.mil***
  - ***Todd Severance (703) 413-4734, todd.severance.ctr@jsf.mil***
  - ***Robin Lutzow (703) 413-4768, robin.lutzow.ctr@jsf.mil***

- Lockheed Martin Aerospace
  - ***Dr. Steve Griggs (817) 777-6574, steven.c.griggs@lmco.com***
  - ***Chris Mengis, (817) 777-7178, chris.mengis@lmco.com***
  - ***Craig Owens (817)777-6504, craig.l.owens@lmco.com (SBIR)***